AMERICAN SOCIETY OF CIVIL ENGINEERS.

THE CANADIAN PACIFIC RAILWAY.

Address at the Annual Convention at Milwaukee, Wisconsin, June 28, 1888,

By THOMAS C. KEEFER, President Am. Soc. C. E.

The EDITH *and* LORNE PIERCE
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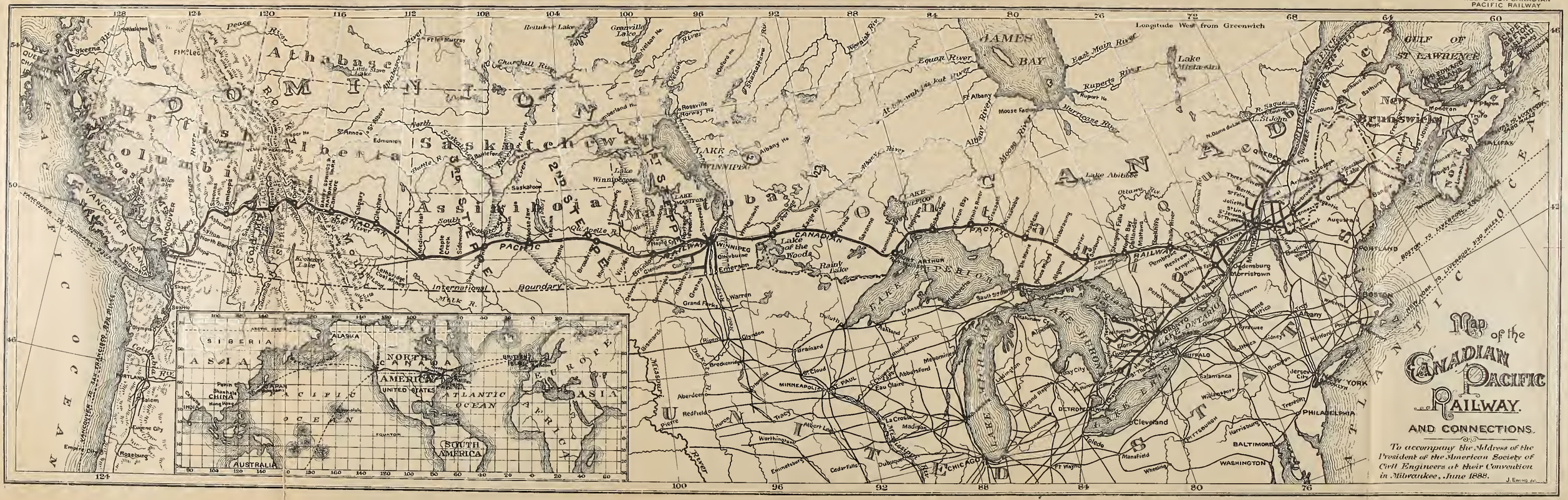
PACIFIC RAILWAY


Map of the Canadian Pacific Railway and Connections.
To accompany the Address of the President of the American Society of Civil Engineers at their Convention in Milwaukee, June 1888.
J. Ewing del.
Longitude West from Greenwich
Dominion of Canada
British Columbia
Alberta
Assiniboia
Saskatchewan
Manitoba
Keewatin
Ontario
Quebec
New Brunswick
Nova Scotia
Prince Edward Island
Hudson Bay
James Bay
Gulf of St Lawrence
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Lake Winnipeg
Lake Manitoba
Lake Nipigon
Lake of the Woods
Rainy Lake
Lake Abitibi
Lake Mistassini
Lake Winnipeg
Lake Manitoba
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Pacific Ocean
Atlantic Ocean
International Boundary
Canadian Pacific Railway
Winnipeg
Minneapolis
St Paul
Duluth
Chicago
Detroit
Buffalo
Toronto
Ottawa
Montreal
Quebec
Portland
Boston
New York
Philadelphia
Baltimore
Washington
Cleveland
Toledo
Vancouver
Victoria
Seattle
Tacoma
Portland
Spokane
Calgary
Edmonton
Regina
Saskatoon
Brandon
Moose Jaw
Medicine Hat
Maple Creek
Sidewood
Lethbridge
Kamloops
Ashcroft
Yale
Nelson
Rossland
Grand Forks
Warren
Bismarck
Aberdeen
Redfield
Pierre
Sault Ste Marie
Port Arthur
Fort William
Sudbury
Algoma
Chicago
Milwaukee
Madison
Dubuque
Cedar Falls
Worthington
Emmetsburg
Albert Lea
Tracy
Hurley
Ashland
Superior
Brainard
St Cloud
Minneapolis
Chippewa Falls
Abbotsford
Eau Claire
Menominee
Marquette
Houghton
Calumet
Alpena
Bay City
Port Huron
Detroit
Toledo
Fort Wayne
Mansfield
Wheeling
Pittsburgh
Harrisburg
Scranton
Trenton
Jersey City
Albany
Syracuse
Utica
Ogdensburg
Morristown
Montreal
Ottawa
Quebec
Three Rivers
Joliette
St Jerome
Pembroke
Renfrew
Arnprior
Smiths Falls
Brockville
Kingston
Belleville
Peterborough
Lindsay
Toronto
Hamilton
Niagara Falls
Buffalo
Salamanca
Warren
Corning
Elmira
Binghamton
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Hartford
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Baltimore
Washington
Halifax
Moncton
Truro
St John
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Edmonton
Vancouver
Victoria
Seattle
Tacoma
Portland
Spokane
Salem
Eugene City
Roseburg
Olympia
Cathlamet
Astoria
Portland
Ashcroft
Yale
Kamloops

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TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

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(Vol. XIX.—August, 1888.)

THE CANADIAN PACIFIC RAILWAY.

ADDRESS AT THE ANNUAL CONVENTION AT MILWAUKEE, WISCONSIN, JUNE 28TH, 1888.

By THOMAS C. KEEFER, President Am. Soc. C. E.

In discharging one of the duties of the office to which I have been elected, I must first express to the Society at large my grateful sense of the high honor conferred upon a Canadian by American engineers —and secondly, my unfeigned regret that engagements (entered into before my nomination) compel me to forego the profit and pleasure of meeting you in Convention, in a year when above all others it would have been both my duty and desire to have done so.

In selecting the subject for my address, I have chosen the "CANADIAN PACIFIC RAILWAY," the most recent, and the most extensive enterprise in a country which, in railway mileage per capita, is second only to the United States. It is not only the most important road in Canada, but it has characteristics which distinguish it from many other railways.

First.—It connects the Atlantic with the Pacific Ocean under one ownership, and upon the shortest American route between Europe and Asia.

Second.—As the single transcontinental line for a country nearly as large as the United States, it possesses the largest area tributary to it of any of the trunk lines.

Third.—No other transcontinental road is so lightly burdened with interest-bearing securities. The whole charge upon 2 500 miles of road is $35 000 000 five per cent. mortgage bonds, $14 000 bonds per mile, or $700 per mile per annum.

Fourth.—As the most recent overland road, it possesses the most modern equipment and the smallest scrap heap.

When the mainland provinces of Eastern Canada (all of which, except the great lake-indented one, Ontario, bordered on Atlantic tide water), became united in 1867 as the Dominion of Canada, the Federal Government took steps to acquire the vast territories between the Rocky Mountains and the watershed of Lake Superior, over which the Hudson's Bay Company exercised jurisdiction—and in which they claimed ownership. Canada refused to recognize the Company as possessing anything more than the right to trade in Rupert's Land, the watershed of Hudson's Bay, and invoked the aid of the Imperial Government. The Company was disposed of by a cash payment of $1 500 000, the retention of their occupied posts, and five per cent. of all lands, lying between the Red River Valley on the east and the Rocky Mountains on the west, and extending as far north as the Great Saskatchewan, which may be surveyed into townships before the year 1920. Over 70 000 000 of acres have already been surveyed, the Company's share of which is 3 500 000 acres, out of which they have sold 470 000. The Company pays for the survey of their lands at the rate of eight cents per acre.

This purchase carried the Dominion of Canada to a line marked by the summit of the Rocky Mountains—between the 49th and the 54th parallel, thence on the 120th meridian to the 60th parallel—which lines form the eastern boundary of the Pacific Province, British Columbia. The 60th parallel is the northern boundary of British Columbia, north of which the Dominion was extended westward to the 141st meridian west of Greenwich, which is the eastern boundary of Alaska in that latitude. This was one of the largest real estate transactions on record.

In 1871, British Columbia entered the Union, thus extending the Dominion of Canada to the Pacific Ocean. The principal condition of this union was that the Dominion should within ten years, connect, by rail,

the seaboard of British Columbia with the railway system of Canada, construction to commence at the Pacific Coast in 1873. Surveys were immediately commenced and prosecuted for about nine years, but the work of construction was not begun until 1875, and then not at the Pacific Coast but at the Lake Superior end. Work was not commenced at the Coast until 1879. Some of the delay is accounted for by the fact that the records of the first three years' surveys were destroyed by fire in Ottawa early in 1874.

The Parliament of Canada had decided in 1872 that the road should be constructed and operated by a private corporation subsidized by the Government, and a contract was arranged in that year with the late Sir Hugh Allan for its construction within ten years, and its operation for a similar period, on the basis of a subsidy of $30 000 000 cash and 50 000 000 acres of land. Sir Hugh controlled a transatlantic steamship line and desired the railway for inland connection. This excited powerful antagonism, and his project was so discredited in the money market that he failed to form his Company. The Government also was defeated on a question arising out of this contract and retired. The new Government was bound to carry out the agreement with British Columbia, but not feeling responsible for its details did not regard time as the essence of the contract, and considered it an impossible one in that respect, especially after the failure of Sir Hugh Allan. It was determined, therefore, in 1874, to proceed with it as a public work, and construction was commenced between Lake Superior and the prairie region in the following year. The Government of 1874 was defeated in 1878, their opponents returning to power, who after continuing the construction as a public work until 1880, reverted to their original policy of construction by a private company. The terms of the contract with the present company were:

First.—$25 000 000 cash and 25 000 000 acres of selected lands in the Fertile Belt, in addition to the right of way for track and stations, shops, docks and wharves, on or through public property.

Second.—Free import of all steel rails and fastenings, fence and bridge material in wood or iron for original construction, and telegraph wire and instruments for first equipment.

Third.—The Government sections under contract—about seven hundred miles—to be completed, with stations and water service, but without rolling stock, and handed over to the Company on the completion

of their contract as a free gift. (The cost of these has exceeded $30 000 000.)

Fourth.—Perpetual exemption from taxation by the Federal Government or by any Province to be created by it, as well as by any municipal corporation of the latter, on all property used for the construction and working of the railway and upon their capital stock. Also similar exemption for the Company's land grant for a period of twenty years, unless sold or occupied.

Fifth.—No line to be chartered south of the railway for a period of twenty years, either by the Dominion or by any Province to be created by it, except for a direction southwest or west of southwest.

The Company contracted to build about 2 000 miles of railway, and to work the transcontinental line for ten years after completion—the standard to be that of the Union Pacific Railway as it was in 1873. Liberal as the terms agreed upon appear, the sequel proved that they were none too much so. The capital stock was fixed at $100 000 000, and it was expected that land sales, or the security of the land grant, would make up any additional amount required and enable the Company to complete the road without mortgaging it. The lands could not be sold while Government lands alongside them were being given away; and land grant bonds, although received at par for Company's lands, could not for the same reason be negotiated to any considerable extent. In the autumn of 1883, $65 000 000 of the capital stock had been sold, and nearly all the proceeds expended in construction. The road was assailed at home and abroad by opponents of the Government and by rival interests, and such distrust created that the remainder of the stock could not be sold to realize the amount necessary to complete the work in hand. The Company then decided to support their stock by purchasing from the Dominion Government a guarantee of three per cent. per annum for ten years, for the $65 000 000 of stock already sold, making similar provision for the $35 000 000 unsold. The cost of this terminable annuity was $16 091 152, calculated at four per cent., to meet twenty semi-annual payments of one and a half per cent. each. Of this amount $8 710 240 was paid in cash and security was given for the early payment of the remainder, but the success of this bold financial policy was defeated by the effect on the money market at this time of the crisis which occurred in the affairs of the Northern Pacific Railway. The stock, with the Government guarantee for so short a term of years,

could not be sold at an adequate price, and the Company, early in 1884, was obliged to apply to the Dominion Government for a loan of $22 500 000. This amount, added to the balance due upon the annuity purchase, made a total loan of $29 880 000, to secure which the Government took a lien upon the entire property of the Company.

In order to obtain feeders and distributors for the transcontinental line, the Company had commenced the construction and acquisition of a railway system in Ontario and Quebec, and branch lines in Manitoba, with a total mileage as great as their contract line, their entire interest in which was transferred to the Government, as well as their unsold stock and their land grant, as security for this loan.

In consideration of this loan, the Company agreed to complete the transcontinental line by May 1st, 1886, five years in advance of the time fixed by the contract.

Railway construction at the rate of nearly five hundred miles per annum rapidly exhausted the loan, and the first lien of the Government over all their property effectually barred the sale of their stock. They found it necessary, therefore, in 1885, to ask that the $35 000 000 of unsold stock in the hands of the Government be cancelled, and an equal amount of five per cent. first mortgage bonds be issued and held by the Government as security for the loan, the mortgage to cover the same security as the loan. The thirty millions loan was payable May 1st, 1891, with four per cent. interest. The Government agreed to accept $20 000 000 of the first mortgage bonds as security for so much of this debt, and the security of the whole unsold lands of the Company (over 20 000 000 acres), for the balance of $9 980 000. Of the $15 000 000 bonds remaining, the Company deposited with the Government $8 000 000 as security for a temporary loan of $5 000 000, and negotiated the remainder, paying back the temporary loan within a few months, and thus releasing $8 000 000 of bonds.

Events took a turn favorable to the Company at last in 1885. The road had been so far completed, that early in that year, and while navigation was closed on the Great Lakes, a military expedition was sent around the north shore of Lake Superior, where there never had been a trail before, to put down rebellion in the Northwest Territories. In November of that year the last spike was driven in British Columbia on a track laid from ocean to ocean. Moreover, the opposition of stock jobbers and rivals subsided, when it was seen that the Government of

Canada were determined to sustain the railway at all hazards. Politically, the existence of the Government depended upon its completion, but the higher consideration was, that the expenditure was so vast and ramified, and the liabilities incurred so great, that suspension would have produced a financial crisis such as Canada had never seen, and one which it was the duty of any Government, if possible, to avert.

In March, 1886, the Company proposed to pay off their indebtedness to the Government, returning all the cash advanced upon the $20 000 000 bonds, and surrendering 6 793 014 acres of land at $1.50 per acre, for the balance. The Government accepted this, and being satisfied that no security was required for continuous operation, surrendered the $5 000 000 land grant bonds held as security for that purpose, but retained $1 000 000 of these to enforce a change of route at Mount Stephen, in the Rockies, where a temporary line of nine miles was adopted to save time and money in opening the road, and upon which there is a grade of 4½ per cent., or double that permitted by the contract.

The year 1887 saw the Company freed from its indebtedness to the Government, and in uncontrolled possession of its property. For the first time since incorporation no legislation for its benefit was required; but in the present year the Government has found it necessary to obtain the surrender of the Company's monopoly as to charters west of Lake Superior, the object of which was to protect their line north of that lake. To effect this, the Government guarantee to pay interest for fifty years on an issue of $15 000 000 three and a half per cent. bonds, secured upon the unsold portion of the Company's land grant—about 15 000 000 acres. The Government becomes a trustee and guarantees the interest for half a century; but not the principal, unless and until placed in funds for that purpose by the Company. The proceeds of land sales are to be funded with the Government, which is to pay three and a half per cent. on any excess of the amount necessary to pay interest upon, or to redeem, the bonds.

The Canadian Pacific Railway is the work of Canada exclusively. The road was undertaken by Canada, as a political and commercial one, to fulfill the compact with British Columbia, and unite together all the Provinces of the Confederacy, but chiefly in order to develop the vast estate purchased from the Hudson's Bay Company. It has been carried out by her people without any assistance from the Im-

perial Government—not even the endorsement of Canadian securities to obtain money at lowest rates, as was done in the case of the loans raised by Canada for the construction of the St. Lawrence canals, and for the Intercolonial Railway. Its importance to the Empire has, however, been recently acknowledged by the British Government, which unites with Canada in subsidizing a line of mail steamers between Vancouver and the British possessions at Hong Kong.

My apology for the space given to the financial history of this railway, is my belief that engineers will wish to know how (as well as why) it has been constructed through a wilderness, and as compared with some of its predecessors, in so short a time. This result is due to the great financial ability, and the still greater courage of its only President, and to the great administrative ability and tireless energy of the Vice-President and General Manager who has had full control of construction and the freest scope in carrying out his plans. Upon the President was imposed the arduous and anxious duty of raising a greater sum than that provided by the Government; upon the Vice-President, the equally arduous duty and responsibility of expending both those sums.

LOCATION.

The general location of the route from ocean navigation at Montreal to the Rocky Mountains, on Canadian territory, is governed by three natural features—Lake Superior, the Lake of the Woods, and Lake Winnipeg. It must go north of the first two and south of the third. Passing from the Ottawa Valley into that of Lake Huron, the line, on its way thence to Lake Superior, traverses for about one hundred miles the watershed of Hudson's Bay near the height of land. In descending thence to Lake Superior, numerous long rock cuts are encountered, separated by shallow valleys, generally with marshy bottoms having little material for road-bed over them or near them except solid rock, boulders and hard pan. Timber of the required dimensions being abundant, the grade was thrown up, shortening the bottom line and reducing the depth of the rock cuts, and trestling was freely resorted to. The embankments have been greatly increased, and much of the rock cutting has been wasted, but it is claimed that from difficulties of position and cost of supplies, the final cost will not exceed that of a slower mode of construction; and, from the local scarcity of bank material, the filling in can be done cheaper by train. The greater

extent of embankment thus obtained has a special value in this district, which has the greatest snow-fall, with the exception of the Selkirk Mountains, of any portion of the route. Along the eastern shore of Lake Superior, high, rocky bluffs are encountered, and heavy rock cuts and numerous tunnels are necessary. The rock excavation runs up to hundreds of thousands of yards on some miles; the cost of one mile is said to approach $700 000.

The highest summit reached between Montreal and Lake Superior is 1 550 feet above tide, or about 950 feet above Lake Superior, and the highest between Lake Superior and Red River is 1 560 feet above tide.

The maximum grade in either direction between Montreal and Lake Superior is one per cent., and the minimum curvature 6 degrees. Between Lake Superior and the Rocky Mountains, the maximum grade going west is, with one exception, one per cent. The exception is a short grade starting from Medicine Hat, a divisional station, where a pusher is always at hand. Coming east, the maximum is 40 feet as far as Winnipeg on the Red River, thence to Lake Superior, 26 feet. This last is the section constructed by the Government.

There is an interesting example of rail creeping on a highly elastic road-bed on this division, where the line crosses a "muskeg"—the Indian term for bog—causing it to yield about 6 inches to every passing train. With a heavy consolidation engine, hauling 35 cars, this track crept 26 inches in the direction in which the train was moving. The rails creep for about three-quarters of a mile east and about half a mile west of a small bridge at the foot of a grade in both directions. They creep with every train, and in warm weather will often run 12 inches under an ordinary train. Track bolts break almost daily, and repairs are to the extent of a box of bolts per month. Cinder ballast keeps the track in line and surface fairly well, but does not in the least prevent the creeping of the rails. Lining and surfacing are necessary at least once a week. On account of the flanges on the angle plates, spikes must be left out of a tie on each side of these plates, otherwise the creeping rail would carry the ties with them, and throw the track out of gauge. Three trains running in the same direction are often sufficient to open all joints on one side and close them on the other side of the bridge between. The whole muskeg, when a train is passing, shows a series of short waves 5 to 6 inches deep, rising and falling with the passing load, and the rails can be seen moving with the passing train.

The General Superintendent of the Western Division, Mr. Whyte, to whom I am indebted for the above, proposes to use 12-foot ties, 40-inch angle bars, and cut a slot in alternate sides of the rail at every tie, as a means of holding the rails in position.

During the construction of this portion of the Railway, two rather serious questions arose out of the interpretation of specifications. The first was upon the work done under the Government, west of Lake Superior; the second upon the work done by the Company east of that Lake. The Government specification for rock read: "All stones and boulders measuring more than 27 cubic feet to be measured as solid rock;" "all large stones and boulders measuring less than 27 cubic feet, and all loose rock, whether in *situ* or otherwise, that may be removed with facility by hand, pick or bar, without the necessity of blasting, to be measured as loose rock." The resident engineers returned as loose rock "large stones and boulders" removed without blasting, but the contractors protested. The question turned on the minimum size of large stones and boulders. Only "large" stones could be counted as loose rock, but there was not this repetition of the word in the case of boulders. The court decided that stones or boulders which were handled and not shoveled were loose rock. Perhaps the words "may be removed with facility by hand," which, as placed and punctuated, apply as well to the stones and boulders as to the ledge rock, influenced the decision.

In the other case, the Company had appointed a successful contractor as Manager of Construction, with plenary powers. The standard Government specification was changed by limiting loose rock to stones and boulders between 1 and 27 cubic feet, and by a special classification for solid rock, the result of the Manager's experience. Some formations of the country rock were known to be harder than others, and no doubt with a view to get a better average, separate prices were taken for granite (the rock of the country), for mica schist and for trap rock. For this last two prices were taken, one for trap in cuttings under, and another in those over 3 feet in depth.

Separate prices were also taken for hard pan and cemented material, but tenderers generally did not recognize any difference in their bids, no doubt because the specification applied the same test for both. It read: "Hard material, where a good picker cannot keep more than two good shovelers going, shall be termed hard pan, or cemented material, as the case may be." The price for hard pan and cemented material

was eighty cents—more than double the earth price; the good picker and the two good shovelers could not be expected to be always together; and however numerous the former might be at any time or place, the "pickings" were good whether the pickers were so or not.

As to solid rock classification, the results on one division were surprising. The geology of the route, which consists largely of metamorphic rocks, was "altered" decidedly. Trap under 3 feet was $3.40 per yard, while granite was $2.20, and more trap was returned at this price than could have existed had all the cuttings been floored with it. When trains could get through, the Company's chief officers found their ballast trains working in cuts where there was no ledge rock, but in which large amounts, including trap, had been returned. They ordered a remeasurement, which was confirmed by another one made by the court; and on one contract the final estimate was reduced between three and four hundred thousand dollars. Other similar cases on this division were settled on the basis of the remeasurement. The section engineers who measured and classified the work in the first instance were generally in accord with the remeasurement, and the sub-contractors were settled with on their classification. After the sub-contractors had been paid off, a revised classification was made out for the final estimate, in which the formation was altered, as effectually as by an igneous eruption, granite merging into mica slate, and trap overflowing everywhere.

The Prairie Section.—The Government had located their line from the Red River to the Rocky Mountains in a northwesterly direction, in order to strike the Yellow Head or Leather Pass, by which route grades of one per cent. were attainable. This direction was also a central one for the largest area of the fertile belt; but it encountered rather formidable crossings of the two Saskatchewans and their tributaries. The Red River crossing is about latitude 50 degrees, and the Pacific terminus but little north of the International Boundary (latitude 49 degrees) while the Yellow Head Pass is in latitude 53 degrees. The route from Yellow Head Pass to the Pacific terminus was necessarily circuitous, and the distance from the Red River to Kamloops* by this pass was 1 350 miles.

The result of the Government surveys showed that the Yellow Head Pass was the most southern practicable one for a line limited to one per cent. grades, and as it was an excellent one in this respect, and was also in the direction of the best line for a colonization road through the prairies, it was adopted. The contract specified this pass, but left the Company their own choice of route to reach it. The question of future competition by parallel lines on the prairies was not considered while

* 253 miles from Pacific Coast, and where all lines meet.

it was a Government road. Such lines, so far as they opened up new country, would have been encouraged by a Government within reasonable limits. But with a private corporation the case was different; it could not afford to take the risks which a Government might safely do. The general direction of their road was nearly due west, and as they were on the 50th parallel at the Red River, they decided to abandon the Government location, and to follow that parallel as closely as possible, both to shorten the through distance and to leave no room for a competing trunk line to the south of them. Possibly, also, climatic considerations, in a latitude where every degree counts, supported this deviation. This line traverses the best of the wheat country for nearly 400 miles west of Winnipeg, and the best of stock raising and mining districts, within 200 miles of the mountains. Between these there lies the only section where there is any scarcity of water. Experimental farms have established that there is sufficient rain for crops, and the chief inconvenience to the Company at present is the want of wells for tank supply to the road. Surface reservoirs are proposed to secure these.

In the prairie sections precautions have been taken against snow blockades by keeping the line in embankment wherever possible, and by widening, and flattening the slopes of necessary cuts, and depositing the spoil well off, as a snow screen. At stations, sidings are thrown out so far that cars standing on them cannot cause drifts on the main line. Only twelve miles of snow fencing are used on the prairie section. There was no detention from snow last winter, between the Columbia River and Lake Superior, exceeding four hours at any one time.

There is no good gravel in large quantities for 400 miles west of Winnipeg, but pockets were found sufficient to ballast the wettest portion of the road. The road-bed is crowned off, and top prairie soil is used for surfacing, which gives a smooth-running track for moderately heavy traffic, and one which it is expected will last at least five years.

The Mountain Section.—In Canada the Rocky Mountains maintain a nearly northwest direction, and may be said to terminate as a distinct range between the 51st and 52d parallel; thence descending to the Peace River Pass, latitude 56 north, which is only about 2 000 feet above sea level. All the rivers on the eastern slope of the Rockies penetrate the range to a greater extent the further north they are found, and the Peace River is the first which cuts entirely through the Rocky Mountain range and heads behind it, draining the table land between the coast range and the Rockies. Between Peace River and the International Boundary, some ten passes have been explored, all lowering northward and diminishing from 7 000 to 2 000 feet; the central one, the Yellow Head Pass, with an altitude of 3 733 feet, having been selected by the Government in the first instance as the route for the railway. The

range, which has an average breadth of 60 miles at the 49th parallel, decreases at the Peace River to 40 miles or less.

The "timber line," which in Colorado is about 11 000 feet above sea level, is reduced to 7 000 feet in the Canadian Rockies; and in the latter, above the height of 6 000 feet, snow falls to some extent in every month of the year. Above this elevation, large patches of perennial snow are met with, and it is in the Canadian extension of the Rockies that true glaciers make their first appearance. These, fed by large snow fields, are the sources of the numerous streams which give summer supply to the great rivers of the plains.

The mountain ranges known as the Cordillera Belt, which on the 40th parallel, spread over a longitude of 1 000 miles in Utah, Nevada and California, are here compressed into less than half that width—one of the ranges, an extension of the Olympic Mountains of Washington Territory, being partially submerged in the Pacific Ocean, appearing only in Vancouver and the Queen Charlotte Islands, and reappearing in Alaska. The three mainland ranges are the "Rockies" or Continental Divide (which in Canada shed their waters into the Arctic and Hudson's Bay on the north and east, and into the Pacific on the west), and the "Gold" and "Coast" ranges.

The mountain section extends from the eastern slope of the Rockies to the terminus at the City of Vancouver in the Strait of Georgia, a distance of 522 miles by the railway, but less than 400 as the crow flies —the railway for nearly the whole distance threading its way through the permanent troughs of what has been described as a "sea of mountains."

While driving the line across the plains on their southern location, the Company were seeking a more southern crossing of the mountains, and had obtained the consent of the Government to any pass south of Yellow Head, provided it was at least 100 miles north of the International Boundary. The Government standard of road was one with maximum grades of one per cent., and the Yellow Head Pass lost its superiority when grades of 116 feet per mile were permitted. The Bow River Valley led up by an easy route from the 50th parallel to more than one pass through the Rockies, by which the Valley of the Columbia River could be reached, always with more or less difficulty on the western slope, which is everywhere the most precipitous. In descending the western slope of the Rockies by the Kicking Horse Pass (the most southern available one), the line is transferred from Bow River by ascending one of its tributaries about three miles in length to its source—which is a marsh on the line of the continental divide from which the water at flood time flows in both directions. This marshy summit is 5 300 feet above tide, and the pass is therefore without cutting or tunnel, as well as without a snowshed. Eastward of this point of departure from Bow River there is no grade to Atlantic tide water exceeding one per cent.,

but immediately after crossing the summit, the heaviest grade on the whole line is encountered, four and one-half per cent., upon two stretches of three and one-quarter miles each, with a three-mile ease between. This is upon what is called "the temporary line," a deviation for nine miles from the contract location (which only permitted half this grade), in order to descend sooner into the bottom of the Valley. The contract location is upon the precipitous face of Mount Stephen, underneath an adjoining glacier, and involved tunneling, increased cost, time and delay in opening the line. There is a temporary curve as well as grade in the Kicking Horse Pass, which was caused by the collapse of a short tunnel from clay expansion. The curve is 23 degrees and is worked by all trains without difficulty at a speed which does not draw attention to the radius. The question will now be between fighting it out on the tunnel line, or avoiding that by a double crossing of the Kicking Horse River.

All the gradients on the Canadian Pacific Railway which exceed one per cent., are concentrated upon the 134 miles which lie between Bow River, three miles east of the summit of the Rockies, and a point one and one-half miles west of Albert Cañon on the Illecillewaet in the western slope of the Selkirks.

The railway route is nearly due west, but the Columbia River, where struck by the Kicking Horse, flows northward to the 52d parallel and there doubles, returning southward and enclosing in this oxbow the formidable Selkirk range of mountains, over which as yet no trail had been discovered. The distance across this range, in the direction aimed at, was less than one-third of that following the river around it, and therefore strenuous efforts were made to discover a pass, which, after repeated trials, was effected by Major Albert B. Rogers, M. Am. Soc. C. E., an American engineer. This Selkirk crossing, the summit of which is 4 300 feet above tide, penetrating a previously unexplored region, is one of the few cases in which the locomotive has preceded the Indian in the formation of any kind of trail.

The Selkirk crossing does not show heavy grading for a mountainous section. Its cost is in its structures over and under the track, which are called for by the snow question alone. Strong and costly sheds are required to meet the avalanche, and large and costly bridges only to get out of the way of it.

THE SELKIRKS.

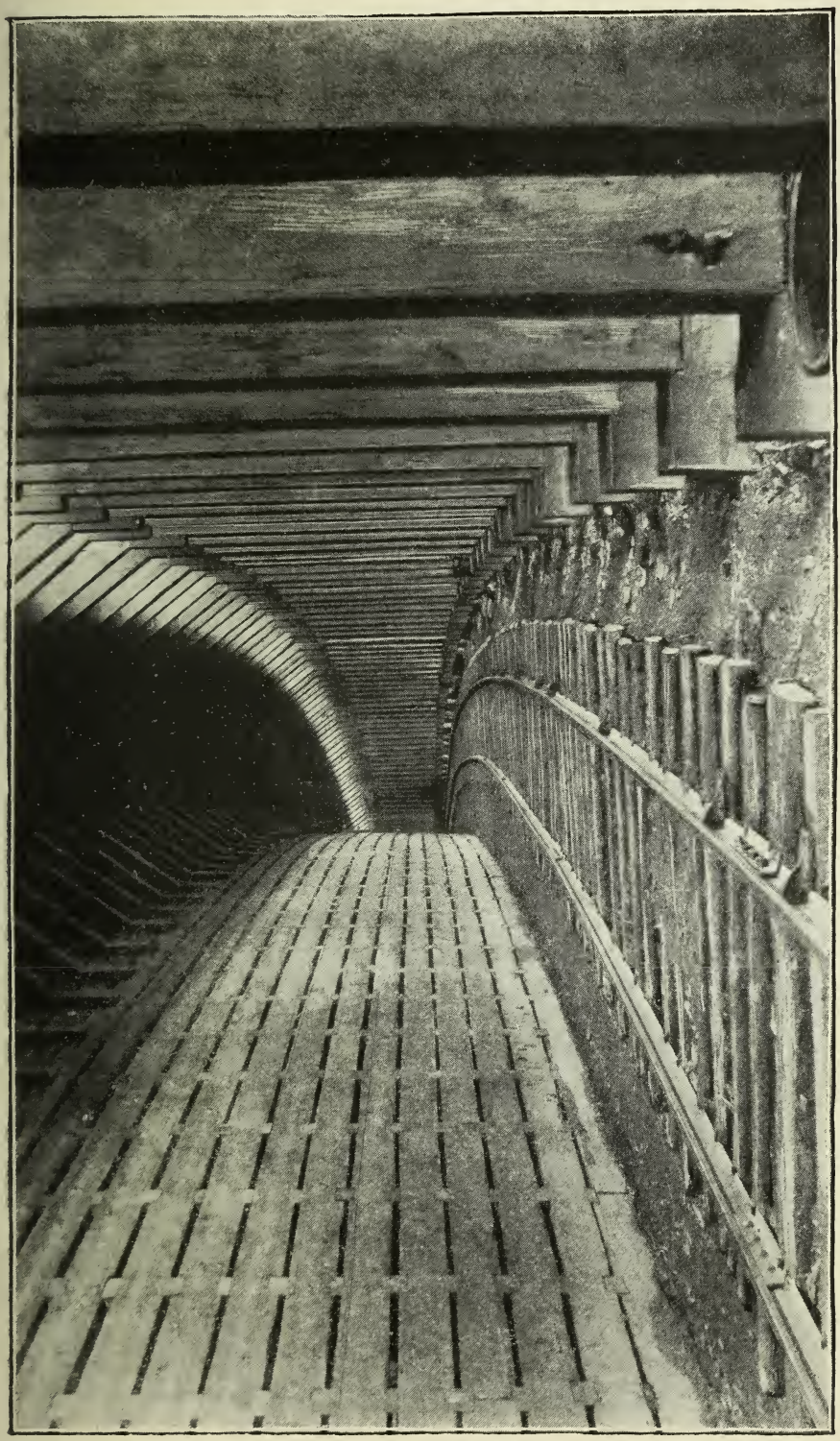
When the last spike was driven in November, 1885, no provision had been made for working the line through the mountains during the following winter. For construction purposes the rails had been laid as rapidly as possible, and the approach of winter suspended completion; but engineers were left behind provided with meteorological instruments, snow-shoes and dog-trains to determine the position, character and ex-

tent of the snow-sheds. The result of this first winter's inspection was the construction in the following summer of 35 snow-sheds, having a total length of four miles. The next winter, the first in which the line was opened for traffic, demonstrated that more sheds were needed, and that existing ones required lengthening in some cases, strengthening in others; that parapets over the portals, and glance-works on the mountain side above were needed to direct sliding snow over the sheds instead of between them. During the summer of 1887, the total length was increased to six miles, and the total number to 53. The experience of the past winter has shown that additions to the sheds are required to the extent of about 4 000 feet, bringing up the total length to about seven miles. The 53 sheds already erected (see Plates V and IX) embrace several types, the primary distinction being, first, those designed for snowfall alone and those exposed to avalanches; and, secondly (as between these last), those exposed to the avalanche on one side only, and those exposed to it upon both sides. These last are called valley sheds, are flat-roofed, and cost about $66 per lineal foot. The typical shed of the Selkirks is an avalanche one, with solid rock-filled crib-work upon the mountain side and strongly braced frame-work for its outer wall. The cost of these range from $40 to $70 per lineal foot, according to location, the increase being due to the greater mass of crib-work required where the avalanche is heaviest. The space between the crib-work and the mountain side is filled in so as to conduct the avalanche over the roof of the snow-shed, without striking heavily against it. The second important type is the gallery shed, which is without crib-work, but has its roof extended against the mountain side upon strong frame-work. The cost of these range from $15 to $40 per lineal foot.

A combination of the typical and gallery sheds is where crib-work is used as a foot wall on the mountain side. This is called "toe crib and gallery" shed, and costs from $27 to $54 per lineal foot.

The gallery sheds are generally extensions of the typical sheds on the flanks of the avalanche and outside its path, and where necessary are terminated by strong parapets as much as 10 feet high to prevent the overflow of the lighter snow from the wings of the avalanche. By means of these parapets 40 to 50 feet of shedding at each end is saved; and the same principle is adopted where slides come down narrow ravines, in which case the profile of the roof is a trough the width of the ravine. These are called "scoop sheds."

During the summer of 1886, fires denuded the mountain sides, leaving no support for the snow on steep side hills, increasing the number of slides and the demand for shed extensions. Sheds were lengthened at each end and connected together until the longest shed exceeded 3 000 feet. Long sheds are objectionable, not only on account of the greater fire risk in summer, but in the handling of long freight trains on the



INTERIOR VIEW OF SNOW SHED.

heavy grades during the winter, when the sheds are entirely dark from snow fall and snow slides. The egress of smoke is then prevented, and brakesmen are unable to see signals or hear whistles. In order to limit the length of sheds, and maintain as many breathing holes as possible, a system of glance-works was devised for the purpose of protecting the necessary openings between sheds. These "split fences," as they are called, are erected on the mountain slope above the track, and are constructed of crib-work or piles, or both. They are triangular in plan, with the apex pointing upward, and on the center line of the snow slides. From the solid triangle which splits the slide, wings are slightly curved and extended, until they pass the line of the shed portals, thus dividing the slide and diverting its course right and left over the sheds. Where there is danger of the snow filling up and overflowing this "split fence," a similar one is placed higher up to cover it. Where only necessary to protect one portal, a glance fence of triangular bents, sheeted with plank, and firmly braced at the back, is planted diagonally with the track, and terminated in strong crib-work at its lower end.

The first winter's experience, founded upon close observation of the character of the slides, proved most valuable in determining the location, design and strength of timber, in the two miles of sheds built the ensuing summer; and by the adoption of wider bents, smaller sized square timber and the more extensive use of the fine round timber, adjacent to the line, for posts and braces, much economy was effected.

The sheds are almost entirely built of cedar, but planking and timbers exposed to transverse strain are of the stronger Douglas fir (Oregon pine) so abundant in the mountains. The cedar in face of heavy cribs is 12 inches square, of lighter "toe cribs" 12 x 10 inches, the back 12 x 12 inches, flatted or round, with 3-inch spaces between the courses. Ties are round, and where the bents are 5 feet centers, break-joints in crib-work every 10 feet, being dove-tailed to the front courses and also to the back flatted timber ones. The saddle-joint is round, and the entire timber work drift bolted together. Dowells are put in foot of plumb posts where gallery is upon toe crib (see No. 4, Plate IX). The joint at the meeting of rafter, plumb, and batter-posts, was, in the first work, so framed as to leave a space for air between the planking of the roof and that on the batter-posts; but it was found unsuitable, because the snow in a slow traveling slide found its way to the track. The joint, as shown in all the drawings, is now used, although not as strong as the first one; the air space is covered by extending the roof, and is kept open until the heavy slides come, when all spaces are securely closed. On this account it is desirable to have the sheds as short as possible, and in view of the success of the split-fence system, suggested by the Vice President and General Manager, Mr. W. C. Van Horne, it is probable that the longer sheds will be cut out at suitable points, and the openings covered by the split fence.

THE TELEGRAPH.—Where sheds are in close proximity, an underground cable is used to secure communication with headquarters in any event, and also promptly to locate the site of any interruption. At isolated sheds and suspected points, very high poles carrying the line clear of all probable obstructions, are employed. The only interruption last winter was caused by wind storms, and the loss of time without communication did not exceed four hours.

FIRE PROTECTION.—There is a very complete system for fire protection in the Selkirks, stationary and locomotive, gravitation and pumping—stationary for sheds, and locomotive for bridges, buildings, timber, tie and wood piles and forest fires, as well as for the sheds. Water by gravitation is abundant, and flumes are erected on the roofs of isolated sheds, and supplied with running water from the nearest stream, barrels and ladders being placed inside. Where sheds are closer, pipe lines are laid with stop valves at each portal and tanks between, so that damage to pipe in one shed would not affect another. The same system applies to the longer bridges. For smaller ones the usual stationary barrels and buckets are provided.

For the locomotive and pumping system, tanks of 6 000 gallons are kept on flat cars at sidings. Each engine has hose connected with the injector by a globe valve, and can draw from the tender or the portable tanks.

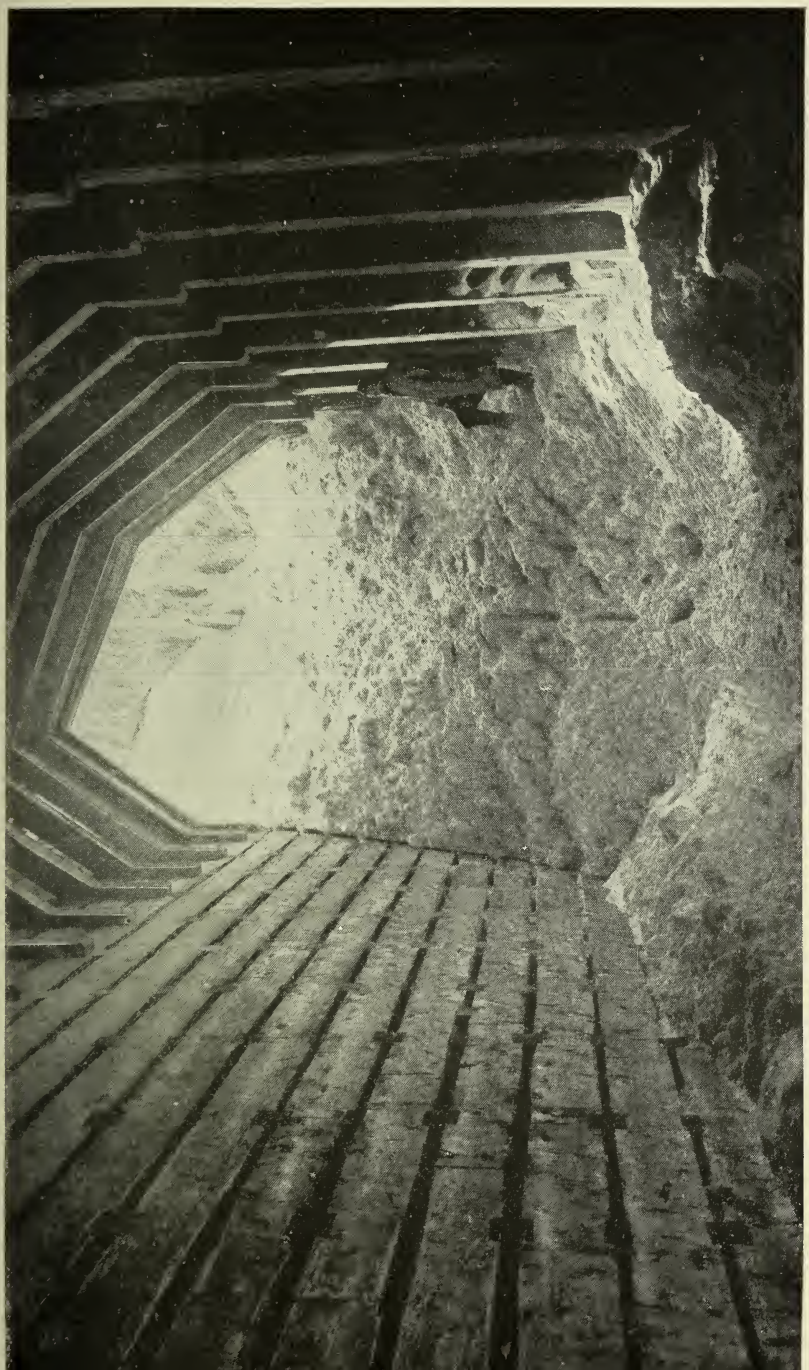
For further protection against forest fires, sand and gravel is dumped from a train around bottom of bridges, trestles, etc.

Where avalanches are expected, the line is thrown well into the mountain side, and the shed roof (which by law must afford a clear headway of 21 feet above the rails) is conformed by back filling as nearly as possible to the mountain slope. Where it cannot be thrown in far enough for this purpose, a broad bench of natural ground is left to take the impact of the avalanche, and send it a tangent to the roof of a comparatively light shed. When the ravines are too deep to be filled up the line is thrown out as far as possible, the ravine bridged with a clear span, the abutments being protected by a glance crib and split fence, and a highway is made for the avalanche to pass under the track.

At the longer sheds an outside or summer track is maintained, both on account of the scenery, which is grandest in the shed region, and also to reduce the risk of fire.

In the 31 954 feet of sheds erected there were used 25 000 000 feet B. M. of sawed material, and 1 140 000 lineal feet of round timber; and the cost of these, including the necessary changes of line to provide for them, of filling in gulleys on the mountain side opposite them, and other work of snow protection, has reached about $2 900 000, and it is proposed to expend about $200 000 more to complete the system.

The sheds were subjected to a very severe test in the winter of



OVERFLOW OF AVALANCHE BEFORE CONSTRUCTION OF GLANCE FENCES.

1886–87, which was more severe than any observed before or since, the snow fall being the heaviest recorded, exceeding 35 feet at the summit in the Selkirks. Eight and-a-half feet fell in six days, and for about three weeks snow was falling almost continually, and slides during this period were very numerous and constant. The sheds proved strong enough in every respect, although subjected to the weight of snow 50 feet deep, weighing 30 pounds to the cubic foot.

The warm Chinook winds and winter rains, followed by frost 30 degrees below zero at times, make the snow very heavy. It has been repeatedly weighed and varies from 25 to 45 pounds per cubic foot, the latter kind being compacted in masses of 5 to 15 cubic yards, and looking more like ice floes than snow balls.

Before the snow-sheds were erected, side cuttings on the slopes exposed to slides were obliterated by the latter, and the *statu quo* of the original snow slope was restored. The snow, which generally brought rocks and trees with it, was packed by the great pressure of the slide so as to be nearly as hard as ice. Black powder was found to work admirably in the side-hill cuts—huge masses being blown down the hill—and the remainder, in heavy blocks, was rolled over the side. In thorough cuts powder was used in heavy charges to break up the snow which was too hard for shovelling, except near the top. Picks and specially-designed ice chisels were here used, and the cut was benched out, entailing a large amount of labor in casting.

The following sketch shows the manner in which the powder was applied in side-hill cuts:

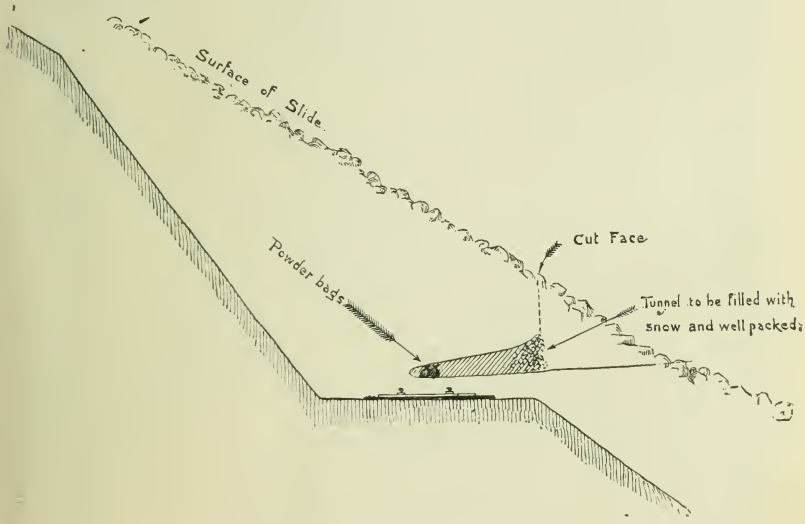


Fig. 1.

One cutting, about 40 feet deep, was full of trees, and presented such a peculiar appearance after being gulletted for the passage of trains, that it received the name of the "Plum Pudding."

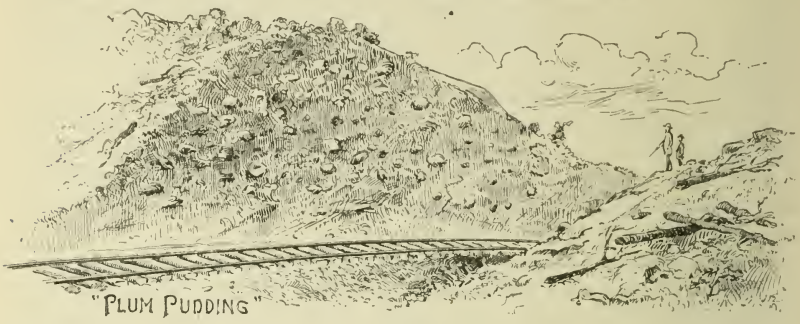


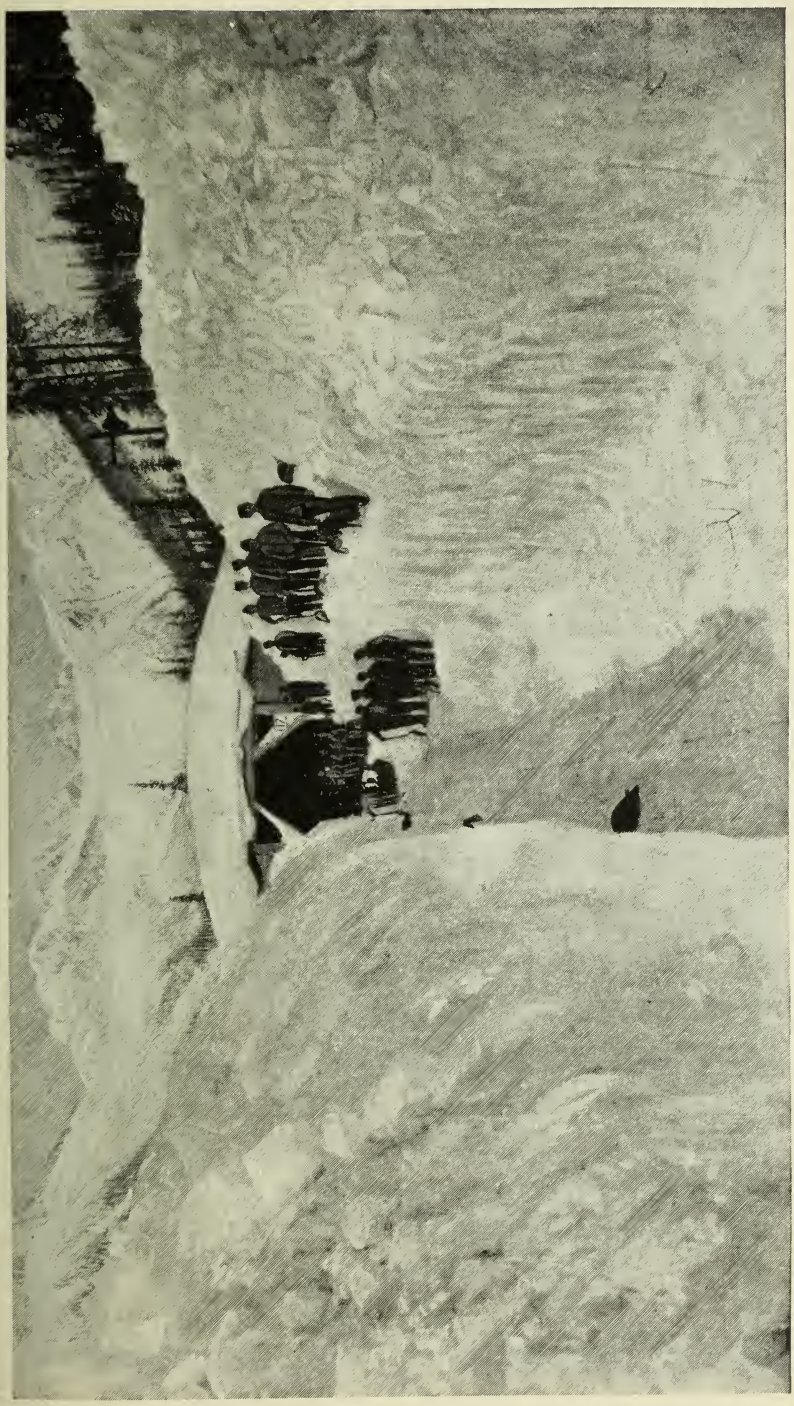
Fig. 2.

The force of some slides was shown by the experience of a valley or double crib shed exposed to them from both sides, the unfinished lower side of which (see No. 2, Plate IX) was left without the batter-post and sloping sheet of plank. When struck on this side, the crib, though filled with stone, was knocked a foot out of plumb, causing the rafter to buckle, the roof being torn off and carried 200 feet up the steep slope above the track. The inside of shed was filled up with snow, which was piled 30 feet deep above it. When clearing out the shed, spaces large enough for a man to go through were found at several points, evidently the effect of confined air, and indicating the rapidity of movement which prevented its escape. Further evidence of air compression was found in the spaces between the wall timbers, which were caulked with snow so hard that no impression could be made upon it without using a pick. It is a question in this case, whether the roof was torn off only, or partly blown off by air concussion.

The sheds exposed to the descent of heavy trees, ice or rocks, have the roof double planked (see No. 6, Plate IX) with intermediate rafters and posts. A rock slide of 100 cubic yards passed over one of these, leaving a specimen rock measuring 128 cubic feet, about ten tons, on top of the roof. In this case the slope of the ground above coincided very closely with that of the roof, exposing the latter only to a rolling load.

The snow-slides vary in intensity from the quiet descent on the slope to the rushing avalanche, bearing rocks and trees, and accompanied, as it always is, with a terrific cyclone more dangerous than either. They sometimes bring down a quarter of a million cubic yards, and are governed by the moist or dry condition of the snow, by the varying slopes of the mountains, the presence or absence of trees, and of sloping crests many thousand feet above grade in the region of eternal snow and of maximum precipitation.

The avalanche is "made up" by excessive snow-fall 4 000 to 5 000



Snow Cut, Summit of Selkirks, Before Extension of Shed.

feet above the level of the track, and "pulls out" over the sloping surface of a glacier, or of old packed snow of the previous winter, until it reaches the steep grade (in some cases at an angle of 70 degrees) and then there is a roar, a crash, a flying scud of snow, and all is over. Its maximum velocity can only be inferred from the imprisoned air spaces already mentioned, and from the force with which a tree was driven through a shed, as shown by the dotted line in No. 4, Plate IX, where it penetrated the backing, the roof and the solid rock filled crib-work, knocking out a plumb post in its passage, and was sawn off 10 inches in diameter at the face of the crib. At some points the avalanches cross the valley and ascend the opposite slope to the extent of 200 or 300 feet. Sheds on a track located over 100 feet above the valley have been struck by avalanches from the opposite side which ascended the slope, passed over them, and climbed the mountain side, 150 feet above their roofs.

Remarkable effects are produced by the local cyclone or hurricane induced by the swift avalanches. This sometimes extends for 100 yards outside the course of the solid avalanche and is called the "flurry," because it is clouded with particles of fine snow. If the course of the avalanche is diverted by some natural obstacle, the flurry drives on in the line of original motion, snapping off huge trees several feet in diameter, at heights 50 feet or more above the ground, without uprooting them. Some in the vortex of the flurry are uprooted, but the majority are cut short off, as they would be by chain shot, and so far from the line of the avalanche that there is nothing to indicate the cause of their decapitation but the snow, impacted like moss against the windward side of their huge trunks. The flurry whirls upward to the height of 100 feet above the descending snow, and forward in advance of it when under full headway, presenting a magnificent spectacle to an observer at a safe distance. December last it picked up a man, and whirled and twisted him so rapidly and spirally, that when dropped he was a limp mass, without a bruise or break in skin or clothing, yet with all his bones broken or dislocated.

Bridges, which have been substituted for trestles carried away by slides, are anchored by guys to "dead men" in the ravine, and thus secured have successfully resisted the "flurry," which, although it caulked the chord spaces very tight with hard snow, did no damage to the structure.

With three-quarters of a mile addition to the snow sheds, Mr. R. Marpole, the experienced and capable Superintendent of the Pacific Division, is confident that interruption to traffic in the Selkirks will be limited to hours instead of days, as has been the case heretofore; and be chiefly the result of local damage to sheds from rocks or trees brought down by the avalanche.

The avalanche season—though a lively and brilliant one—is short in

comparison with the glacier one, and when the exposed points are all protected, interruptions due to the environment will have little appreciable effect upon the general traffic of the year. There will be an exceptional item for maintenance here in excess of any other division of the road, but I believe it will be fully met by the exceptional attractions of this glacier section. The avalanche may attract hundreds of bold admirers for two or three months of winter, but for the greater portion of the year the silent majestic glaziers, which may be approached without risk, will draw thousands of tourists into the Selkirk range, where there is no danger when there is no snow in motion.

Mud Slides.—A great deal of trouble has been experienced from mud slides and "gumbo" cuts, generally below the snow-shed level in the flanks of the Selkirks, and chiefly on their western or wettest slope. In forcing track laying many slopes were left too steep; but there are cases where the angle of repose, without any provocation, has proved to be a very obtuse and inconstant one, giving rise to acute expressions of disgust on the part of the roadmaster, and affording a signal illustration of total depravity in inanimate things. In comparison, the snow slide from above is clean and respectable, but the trouble in gumbo cuts is low in origin, of vicious proclivities and of the earth, earthy. No amount of cleaning is appreciated, and it requires to be sat upon. To effect this, the cut is deepened by steam shovel and derrick, and secured by a double row of piles on each side, 8 feet apart, the lower one (in the ditch) at 5-feet centers, the upper one (on the slope) of 3-feet centers. The inner row of piles is kept in position by a horizontal flatted sill across the track below subgrade, and the outer rows by similar but sloping braces between the tops of the inner and outer piles. A single log is run behind the ditch piles under the sloping brace, and a wall of about five logs high is carried up behind the outer row. The slopes are removed and coarse gravel is filled between and behind piling and in ditches, which permits all water to ooze through to the latter, where, owing to the grade, it readily gets away.

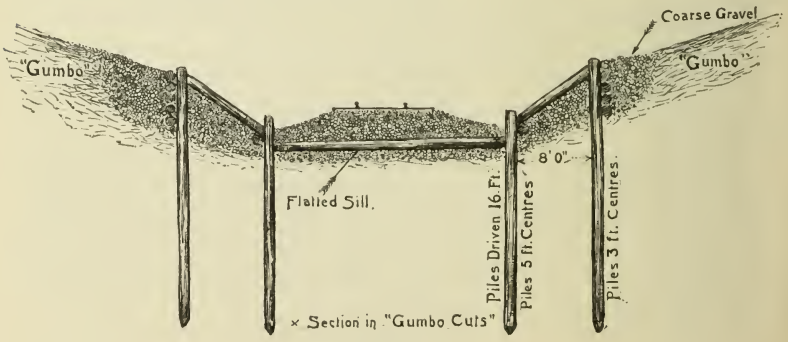


Fig. 3.

The "gumbo" of the Selkirk slopes is not the material called by that name in California, where it is found upon the surface of level plains, and bakes and cracks with the sun, but becomes a sticky mud with every rain. The Selkirk material is a sandy loam quick sand, and would be steady enough if it had not imbibed so much—water.

The sketch on opposite page explains the manner in which it has been successfully dealt with in the cuttings.

Bridging.—All the bridging in the mountain section was at first necessarily of wood, which is abundant and of excellent quality there. Some of these have already been replaced with steel. The section built by the Government at the Pacific end of the road—with the exception of the cantilever across the Fraser—has wooden bridges of the Howe truss pattern. In the Selkirks there are three high bridges—154, 175 and 294 feet in height respectively. The last, the Stony Creek Bridge, is 490 feet in length, the greatest span being 172 feet, resting on wooden towers 200 feet high, standing on a concrete foundation. It is probably the highest wooden bridge in America. It is soon to be replaced with a steel arch springing from the rocky sides of the V-shaped ravine, about half way of its depth; and the other two high ones, with iron trestles. The metal bridges erected by the Company, east of the Rocky Mountains, are of heavy pattern, designed by the late C. Shaler Smith, M. Am. Soc. C. E. Where through trusses are unavoidable, these have a width of 20 feet between centers.

Besides much that has been filled in, there yet remains a large amount of trestle work east of Lake Superior and upon the Government section at Pacific Coast, which has been substantially built and floored, as it will under any circumstances require years to substitute permanent work for them. The Company has bound itself to expend the whole of the $15 000 000—interest on which is guaranteed by the Government for fifty years, in consideration of the abandonment of their monopoly—upon the main line between Quebec and Vancouver. Of this amount five and a quarter millions is apportioned in the agreement to rolling stock, five and a half millions on capital account to "buildings, snow-sheds, sidings, permanent bridges, filling in trestles, reducing grades and curves, and other improvements." The remaining four and a quarter millions is apportioned to "elevators, bridges, locomotive shops, filling trestles, sidings, docks, and lake and coast steamers."

By crossing the Selkirks instead of going round them in the Columbia River Valley, the road is shortened about eighty miles. The fall in the Columbia River between the first and second crossings (going westward) is 1 100 feet, an average of about 7 feet per mile. The river has its cañons, and in places washes the base of the mountains, so that heavy work and possibly some tunneling would have been encountered on the longer route.

On leaving the Columbia at the second crossing, and where it soon ceases to be a Canadian river, the line crosses the Gold Range through the Eagle Pass, a remarkably favorable one, the summit being only 1 800 feet above tide, although in a range with many snow-capped mountains. There are nine snow-sheds, with a total length of 1 360 feet, all on the western slope of the Eagle Pass. From the western side of the Gold Range, the line follows the shores of lakes and rivers which discharge into the Pacific Ocean upon Canadian soil. In crossing the Dry Zone or bunch-grass grazing plateau of British Columbia, there is heavy work and tunneling along the rock-bound shores of the lakes; but it is when the line descends the Thompson and Fraser Rivers, where these cut through the Coast Range, that the heaviest consecutive hundred miles on the whole route is encountered. This section, built by the Government, cost about $10 000 000, or $80 000 per mile, without rolling stock or stations. There are numerous tunnels and rock cuts, as well as heavy earth cuts, and a fine cantilever of 300 feet span across the Fraser River, which was the second erection of the kind in America, and was designed by Mr. C. C. Schneider, M. Am. Soc. C. E.

THE EQUIPMENT OF THE LINE.

The Canadian Pacific Railway is a modern road, having had the utmost freedom of location in unoccupied territory, for stations, yards and shops, and has not therefore been handicapped by costly accumulations of antiquated rolling stock, or hampered by limited yard accommodation on any portion of the contract route—conditions which have proved so onerous to some older roads.

The divisional points are placed as nearly as possible at intervals of 125 miles, any variation from this being due to the questions of suitable station ground, or water supply. At these points, the tracks are arranged as shown on the standard plan, the object being to provide a yard that may be readily extended—one in which the main track is broken as little as possible by switches, and so arranged that any car in the yard may be reached by one shunt.

At alternate divisional points, shops are established of sufficient capacity for repairs of rolling stock on two working sections, and at the divisional points between these there are smaller shops with the few necessary tools for ordinary breakages. Engines run from the larger shops to the smaller ones, so that ordinarily they return to the principal shop points every other day.

At all divisional points, the water tanks are erected 40 feet high, to give a sufficient pressure for washing out engines.

At the alternate points, wrecking cars, pile drivers, tool cars, bridge and track material, are provided for any emergency on the sections either way from them, and a smaller supply of emergency material is kept at the intermediate points.

In the newer country, stations are arranged at intervals of about 16 miles, governed by ground and water supply, with accommodation for two section gangs of eight men each, a combined freight and passenger station, a 50 000-gallon tank, and a telegraph office, ensuring collection of section gangs for any emergency in the shortest possible time. These regular stations have side tracks according to trains handled on the division, and, where local traffic exists, a business track as well as a passing track. Passing tracks are laid about half way between these stations, making the crossing interval generally eight miles; but this is reduced where there is considerable traffic.

At Montreal, the principal eastern terminus; at Vancouver, the Pacific terminus; and at Winnipeg, which is midway between them and has 24 miles of sidings, large shops exist for heavy repairs of cars and locomotives. As these three points are 1 500 miles apart, large intermediate shops will be required as traffic increases.

Fuel Supply.—The fuel supply is: Nova Scotia coal for the eastern system, which is carried a short distance west of Ottawa; Pennsylvania coal from this point to Brandon, on the prairies, the first divisional station west of Winnipeg. This coal is brought by rail across the St. Lawrence and Niagara Rivers, and by water to Lake Superior. West of Brandon, Canadian tertiary coal from the Bow River deposit is used, until it is met in the mountains by the Pacific Coast coal from Vancouver Island. The Bow River coal is estimated to be within fifteen per cent. of the value of Pittsburgh coal. Anthracite is being worked alongside the main line in the Rocky Mountains and is used for passenger cars and domestic purposes as far east as Winnipeg, but export is as yet chiefly to San Francisco. When more extensively mined and fire boxes are altered to burn it, it may displace other coal in the mountain section.

Windmills have proved successful for pumping on the prairies. The water is prevented from freezing by a heating pipe passing up through the center of tank.

Locomotives.—The consolidation engines working the Selkirk Division were built at the Company's shops at Montreal. They are distinguished by their short stroke, 22 inches, high boiler pressure, 160 pounds, and large grate surface to maintain this pressure. Their weight, 94½ tons, is sufficient to prevent slipping in good weather, when hauling full train of seven coaches, without the use of sand, but this is provided both front and back for bad weather. The tractive force is 155.7 pounds per pound pressure on pistons, the wheel base short in proportion to diameter of drivers, and being carefully counterbalanced, they run with speed, ease and steadiness around sharp curves. Their brake power is the Westinghouse on two forward pairs of drivers, and the American

Steam Brake on the two hind pairs. The Water Brake is also applied to all engines running in the mountains. The automatic brake is used in ascending, and straight air in descending, with hand brakes manned. The Block system, with telephone addition, is extensively used in the mountains.

The principal dimensions are:

Diameter of cylinder and length of stroke, 19 x 22 inches.
Distance apart of centers, 6 feet 11 inches.
Length of connecting rod, 9 feet 2 inches.
Driving wheels, diameter, 4 feet 3 inches.
Driving wheel tires, width and thickness:
First and fourth, 5½ x 3 inches, flanged.
Second and third, 6 x 3 inches, blind.
Fixed wheel base, 14 feet 3 inches.
Total wheel base of engine, 21 feet 3 inches.
Center of cylinder to center of driving axle, 13 feet.

Weight on track in working order.....	13 100	pounds.
Weight on drivers in working order.....	90 900	"
Total weight of engine.....	104 000	"
Weight of tender, empty.....	35 000	"
Capacity of " coal.....	20 000	"
" " water.....	30 000	"
Total engine and tender, in working order,	189 000	"

Snow Ploughs.—In winter these consolidation engines are furnished with a large heavy pilot plough, shown in drawing, Plate IX. This plough has rendered excellent service and has repeatedly opened the way through packed and saturated snow, where the large wing plough had failed, enabling the latter to follow with wings wide open, nose down and flanger working, securing a good rail. These ploughs are of $\frac{5}{16}$ iron, double plated at nose, steel angles, and 6-inch by 1-inch iron strap stays. The height of nose is 5 feet and of wings at ends 7½ feet, clearing a width of 9 feet at bottom and 10 feet at top.

The regular snow train has a strongly built plough, wings 16 feet across, and nose 11 feet above rail, the lower or horizontal portion of which is raised or lowered from inside, and when pressed down by weight of snow, is carried by rollers running on top of rails. The flanger is adjusted to turn over on meeting any obstruction harder than ice or packed snow. For this train Y's are put in, through which the whole train can be turned and see-saw back and forth, giving no rest to the wicked drifts or slides. "*Principiis obsta!*" is, during snow storms, the motto on the crest of the Selkirks.

For the efficient working of the snow plough train, it has been found necessary in many places, and where possible, to remove the line out from the hillside, to leave room for the accumulation of snow on the slopes, and a chance for the inside wing of the plough. This consideration is apt to be overlooked during a summer location in a mountainous, snow affected region, especially when working against time, or upon too economical lines. The teachings of experience in the Selkirks have been many and valuable, and none more so than this, the question of sea room for the plough, and of store room for the snow.

The freight engines are heavier and more powerful than the passenger ones; cylinders 20 x 26; 4 pairs of 48-inch drivers; wheel base, 21 feet 11 inches; driving wheel base 14 feet; weight, 116 000 pounds; weight on drivers, 102 000 pounds. These engines haul 12 loaded cars up the Selkirk slope, which has grades of 116 feet per mile. In descending long heavy grades with these trains, frequent stoppages are made to cool off, and prevent breakages in the cast-iron plate wheels. This precaution is not necessary with passenger trains, in which no cast-iron wheels are used.

On the Selkirk division steel rails of 72 pounds weight per yard are used, with 3 500 ties per mile.

Provision Magazines.—The Company have omitted no precautions to secure the safety and comfort of passengers. For hundreds of miles no supplies can be procured except by train, and in view of detentions, each through train from Montreal, in addition to the dining-car supplies, carries, in the baggage car, an emergency box of provisions, to be used exclusively for passengers, and only in case of necessity. Besides this, at nine points on the Selkirks and Eagle Pass, where detention by snow slides is possible, provision magazines are established in safe positions, at intervals of about ten or twelve miles; so that no train may be caught more than six miles from food. These provisions are emptied in the spring, and replenished with fresh supplies in the autumn. Coal and oil supplies for the passenger cars are also similarly "cached," and emergency fuel for the locomotives, bridge and track material are held loaded on cars, to shorten detention of trains.

Extremes meet — the voyageurs of the Hudson Bay Company, Arctic explorers, and the hunters and trappers in the mountains, cached their surplus stores against the ravages of fire, of the loup cervier, the wolverine or the polar bear; and now the most recent specimen of the highest type of transportation confirms, by its emergency magazines, the wisdom of the pioneers in the old time before the railway era.

PROSPECTIVE TRAFFIC.

The Canadian Pacific Railway has been opened for traffic through 2 500 miles of territory almost uninhabited, and so rapidly that settlement could not keep pace with it. The 1 900 miles and over of main line constructed by the Company has been built in half the time allowed by the contract, and within these five years a subsidiary system, about 2 300 miles in length, has been built or acquired, by which the main transcontinental line has already been made more than self-sustaining. The capital account is not yet closed; another five years will be required to convert temporary into permanent work, and new demands will arise from extension of traffic, both on the prairies and in the mountains. Under these circumstances, no adequate conception of its importance can be formed without some consideration of the character of the country it traverses, and upon which its future depends.

The Eastern Section.—The starting point of the national road, as a Government work, was a point near Lake Nipissing, called Callander, about equally distant from Ottawa and Toronto, and about two hundred miles due north from the latter. This point had no connections, and no special merit but that of being equally inconvenient to the rival Provinces of Ontario and Quebec, both of which were placed on equal terms in reaching it with their provincial lines. One hundred miles west of Callander is Sudbury, the junction of the important line from St. Paul and Minneapolis, *via* Sault Ste. Marie, by which those cities find their shortest all-rail route to Atlantic tide-water. Sault Ste. Marie is rather nearer to Montreal than Detroit is, with the advantage that, like the Niagara and St. Lawrence rivers, its broken navigation makes it a bridge route.

It is not necessary to refer to the country east of Sudbury, which is a lumbering, agricultural and mining region, quite capable of sustaining a railway, even without the traffic of the Sault route. From Sudbury westward, the line cuts through continuous forest for 360 miles, until it strikes the shores of Lake Superior, which it skirts for 200 miles, and then leaves in a very direct line through a forest and lake region for the outlet of the Lake of the Woods, nearly three hundred miles farther west. The 850 miles from Sudbury to Lake of the Woods is through a country of similar character—a mountain and lake region—with very limited arable areas, but very promising mineral ones, and with an immense supply of timber invaluable to the railway, but much of which is, at present, commercially beyond the reach of market. Innumerable lakes, some more than 20 miles in length, are tapped by the railway, which, with their thousands of miles of coast line, will yield valuable supplies of timber, as soon as the nearer ones are exhausted, or the price makes exportation profitable. The 200 miles shore line on Lake Superior,

with excellent harbors at the extreme points, afford landing places for water-borne coal from Ohio and Pennsylvania, for carriage east and west, as well as reach the valuable fisheries of the coast.

Near Sudbury and Port Arthur, gold, silver, copper and iron have been discovered, and, with the exception of the iron, are being worked. Upon the extension of these discoveries, in what is all known to be a mineral region, between Sudbury and the Lake of the Woods, as well as upon the lumber trade, the building up of a local traffic will chiefly depend.

The Lake of the Woods has an area of 700 square miles at an elevation of 1 062 feet above tide water. Its drainage area is about twenty-five thousand square miles—7 000 miles of which are in Northern Minnesota—which its water-shed penetrates to the head waters of the Mississippi at Lake Winnipegoshish. In Canada its water-shed begins within 30 miles of Lake Superior. It discharges into Winnipeg River with a fall of 21¼ feet, at the foot of which the river turns abruptly westward and runs for three miles parallel with the lake shore, and separated from it by a narrow natural dam of rock, through which, at half a dozen points, the lake waters can be conducted by a flume of 100 yards in length. The estimated water power at this dam is 65 000 H. P., and between it and Lake Winnipeg the river has a fall of about three hundred feet. The railway line follows this dam, and saw-mills with cutting capacity of 60 000 000 feet B. M. per annum, working twelve hours daily, are in operation, for the supply of the prairie region as far west as Regina, nearly five hundred miles, where it meets the timber and lumber from British Columbia. It is estimated that the timber supply from this point is good for thirty years, at double the present rate of consumption.

A flour mill, of 1 200 barrels daily capacity, has recently been erected at Keewatin. There was a surplus wheat crop in Manitoba last year, exceeding ten millions of bushels, grown within an average haul of 250 miles of Keewatin. Thus there is already a possible wheat growth sufficient for half a dozen such mills. There are already forty-four elevators at way stations, with capacity of over two million bushels, and a still larger storage capacity for these on Lake Superior. The wheat elevators already extend more than 300 miles west of Winnipeg.

The Plain and Prairie Section.—The Rocky Mountains, which, from Santa Fé, in New Mexico, to Cheyenne, in Wyoming, run due north through Colorado on their most eastern projection, turn at Cheyenne (longitude 105 degrees west from Greenwich, or 28 degrees west from Washington), running northwest to the International Boundary, and at Calgary (the Canadian Denver) strike the 115th meridian (38 degrees west from Washington), carrying the plain and prairie regions 10 degrees farther west than they are in Colorado. The width

of the Canadian fertile belt west of the Red River, is about the same as that of the prairie regions between Indiana and Colorado.

The prairie section, according to the Canadian Geological Survey reports, may be said to extend from the Red River on the 97th meridian west from Greenwich, to Calgary near the Rocky Mountains on the 114th meridian, a distance of 800 miles, and from the 49th to the 54th degrees of north latitude. There are three distinct plateaux or "steppes," sloping from the Rocky Mountains northeasterly towards Lake Winnipeg and the Red River, having well-defined escarpments running northwesterly parallel with the range. The general slope from the foot hills of the Rockies averages about five feet per mile. The lowest of these plateaux averages about eight hundred feet above the sea, and embraces an extensive lake system nearly fourteen thousand miles in extent, the largest (Lake Winnipeg) covering 8 500 square miles. The total area, including the lakes, is 55 000 square miles. This interior basin, the lowest of the continent, generally known as the Red River Valley, has the finest wheat land perhaps in the world. It is only 52 miles wide at the International Boundary, and rises thence southward for about two hundred miles, attaining an elevation nearly one thousand feet above sea level.

The second steppe is about two hundred and fifty miles wide at the 49th parallel, and 200 miles at the 54th, having an area of over 100 000 square miles, 71 000 square miles of which form the eastern portion of the Great Plains. Its average elevation is 1 600 feet above sea level.

The third steppe has an average elevation of 3 000 feet, being 4 000 feet at the foot hills and 2 000 feet at its eastern edge. Its area is 134 000 square miles, of which 115 000 are almost entirely devoid of forest. Its breadth on the 49th parallel is 465 miles.

The total area south of the 54th parallel is 280 000 square miles—about one hundred and eighty millions of acres—of which, after allowing for swamps and lakes, mountains and barrens, by far the greater portion is arable.

The agricultural capabilities of the Canadian northwest are not, however, limited by the 54th parallel. That latitude is the northern boundary of the great plain and prairie region, which extends from Mexico through the United States to the Great Saskatchewan. Narrowing northward of the Winnipeg Lake basin, by the encroachment of the Laurentian formation on its eastern border, it extends as broken prairie and wood land to the shores of the Arctic Ocean, where its breadth is reduced to between three hundred and four hundred miles. Beyond the North Saskatchewan River, it loses its essentially prairie character, and from increasing moisture of climate becomes generally thickly covered with coniferous forest. From the best estimates which can be made in this imperfectly explored country, it is believed that it contains at least 120 000 000 of acres of arable and pasture land north of the 54th parallel.

Thus there is in the Canadian northwest about three hundred millions of acres of arable and pasture land, of which one-third or more may be capable of producing wheat of the finest quality known.

In a recent report of the Senate of Canada, it is stated that this northern forest-covered region embraces also the greatest fur producing country in the world, supplying three-fourths of all the valuable furs sold in Leipsic and London, to the annual value of millions of dollars.

The climate of the eastern slope of the Rockies, for a belt of over one hundred and fifty miles in width is, as compared with the plains on the same latitude eastward, exceptionally mild in winter. A southwest wind called the "Chinook," blowing at right angles to and over the Rockies, brings a thaw, removing snow and enabling cattle to feed out all the year round. At Canmore, in the Rockies, 4 200 feet above tide, cattle range out all winter. The remarkable warmth of a wind flowing for hundreds of miles over snow-covered mountains, could not be accounted for by the proximity of the warm waters of the Pacific, and is explained by the alternate expansion and condensation of air flowing from the ocean level over the mountains, and descending thence to the plains below. As the moisture is evaporated, or the air expanded, in rising over the mountains, latent heat is absorbed which is given out again by the condensation of the moisture or the compression of the air in descending to the plains below.

Another climatic feature peculiar to all high latitudes, which, according to Dr. Dawson, of the Canadian Geological Survey, is believed to account for the ripening of grain and vegetables in the Peace River region and north of the 60th parallel, is the greater length of the day and the greater amount of sunshine, the sun rising on June 21st at three hours and twelve minutes and setting at eight hours and fifty minutes.

The Bow River coal area is estimated to contain 330 000 000 of tons, and will be the chief source of supply for the prairie region and for many hundred miles of the railway, and an increasing source of traffic for the latter.

Natural gas has been discovered in boring for water near the foot hills, and is used for pumping at two of the Company's stations.

The Mountain Region.—The Rockies, where crossed by the Canadian Pacific Railway, are separated from the Selkirks (one of the Gold ranges), by the Columbia River flowing north; and the Selkirks from the Gold Mountains, by the same river flowing south. Between the gold and coast ranges lies an undulating, bunch grass region known as "the dry zone," one of the finest grazing districts in Canada, but where crops require irrigation. This interior plateau has an average width of 100 miles, and an average elevation of 3 500 feet. There is an excessive rain fall on the coast, averaging about six feet per annum, falling chiefly be-

tween October and April, and a very great precipitation, particularly of snow, upon the Selkirks. The rain clouds from the Pacific being elevated by the coast range (with its higher peaks of 6 000 to 7 000 feet average, and some exceeding 9 000 feet), pass over the interior plateau, and precipitate their stores of rain or snow upon the Gold Mountains, and chiefly upon the highest of these, the Selkirks. The Rockies, therefore, although the loftiest of all the ranges, are the driest, and no snow-sheds are required in them.

The agricultural resources of British Columbia are limited chiefly to this interior plateau and to the delta of the Fraser River. Lumber, fish and minerals, in each of which her resources are unsurpassed, are the great features of the Pacific Province, and these industries will furnish a local market for her agricultural products, her exports of which will, until irrigation is extended, be confined to horses and cattle. Through the Rockies, Selkirks and Gold Range, the railway has penetrated a hitherto inaccessible region and opened up a virgin forest, in which Douglas fir (Oregon pine) and cedar abound, with spruce and various pines. The first two are timbers of such value that they will bear rail transport to the northern Atlantic coast, where we have nothing to compare with them. Lumber is now exported from British Columbia to Japan, China, Australia and South America. Since the commencement of the railway, saw-mills have been established at eight different inland points in the mountains.

Coal and iron abound at tide water, as well as in the Rockies—the former the best in quality yet found on the Pacific coast, half a million of tons of which are now exported annually. Fifty millions of dollars in gold have been washed out in the Province in the last thirty years, and quartz mining is now becoming a result of the railway. Silver is mined of sufficient richness to bear transport to a smelter at Omaha, a carriage of 1 750 miles. Smelting works and sampling mills are now being erected with the assistance of the Provincial Government.

Over 3 600 tons of canned salmon are exported, nearly all to Great Britain. The railway has opened an eastern market for this fish in its fresh state.

The railway has created a terminal city, which will soon surpass the older ones of Victoria and New Westminster, and has given an impetus to the coasting trade which reacts on itself; so that, with the wonderful natural resources of this Province, the commercial success of the road in its freight traffic is already assured in the mountain region, where so little was expected at the first, that security was required by the Government for ten years' continuous operation of the road.

The Asiatic commerce is yet in its infancy, under temporary arrangements with chartered steamers. When the subsidized steamers now under construction for this trade are put on the route, both freight and passenger traffic may be expected to assume important proportions.

Lumber and flour are principal articles of export; teas, silks and curios, of import. Both New England and Canadian cotton manufactures have been exported to China by this route.

For local passenger traffic, which from the sparseness of population has, like the freight business to be created, there is chiefly that of prospectors for minerals and timber, ranchmen, miners and lumbermen, and settlers in the new towns, which can be regarded as tributary to the road. Through traffic with all the Pacific coast is competed for, and tourist travel is specially cultivated. For this, the route through the mountain region offers exceptional attractions, and no expense has been spared to make the most of this class of traffic. The hotels at the National Park in the Rockies, and at the terminus, Vancouver, are, like all the Company's equipment, modern and complete. The scenery is Alpine, the route the only glacier one in America, and comfortable hostelries have been established in the mountains for stop-over tourists or sportsmen wishing to hunt the Rocky Mountain goat, now about limited to these latitudes, the big horn, the grizzly and the mountain lion; or, farther north, the cariboo; and in the foot hills, deer, elk and antelope; or to cast a fly in the trout streams and lakes of the mountain regions.

CANADIAN PACIFIC RAILWAY.

Condensed Balance Sheet, December 31st, 1887.

Cost of Road.		
Main Line (including dividends paid, less net earnings to date)	$116 618 039 28	
Acquired Lines	12 665 205 53	
Branch Lines	2 850 253 59	
Algoma Branch	3 556 131 11	
		$135 689 629 51
Note.—Lines built by Government not included. Estimated cost, $35 000 000.		
Equipment.		
Rolling stock	$9 107 067 95	
Lake steamers	478 952 99	
Shops and machinery (Montreal, Hochelaga, Perth and Carleton Place)	984 912 28	
		10 570 933 22
Construction plant, tools and outfit	.....	124 702 63
Real estate (at and near Montreal)	.....	283 785 80
Advances and Expenditures on Leased Lines.		
Southeastern Railway	$1 604 780 53	
St. Lawrence and Ottawa Railway	296 414 34	
Ontario and Quebec Railway	1 679 363 40	
	$3 580 558 27	
At credit of Atlantic and N. W. Ry. (amount in hand for completion of line)	1 780 271 10	
		1 800 287 17
Station balances, accounts receivable, and miscellaneous securities outside of capital account	.....	2 615 323 29
Material and supplies on hand	.....	1 885 535 12
Dominion Government Guarantee Fund.		
Amount on deposit to guarantee 3 per cent. per annum on capital stock until August 17, 1893	.....	10 310 954 75

Capital Stock			.....	$65 000 000 00
Mortgage Bonds.				
First Mortgage 5 per cent., £7 191 500			$34 998 633 33	
Canada Central First Mortgage, amount of issue £500 000	$2 433 333			
Sinking Fund deposited with Dominion Government	1 500 000			
Amount necessary to redeem balance at maturity			850 000 00	
Canada Central Second Mortgage Bonds, 6 per cent			973 333 33	
Due Province of Quebec on Q., M. O. and O. Ry., 5 per cent			3 500 000 00	
Due Province of Quebec on North Shore Ry., 5 per cent			3 500 000 00	
North Shore Railway First Mortgage Bonds			436 053 00	
				44 258 019 66
Land Grant Bonds, First Mortgage.				
Amount of issue	$25 000 000			
Less amount redeemed and cancelled	16 529 000			
			$8 471 000 00	
Amount held in trust by Dominion Government and not bearing interest	$1 000 000			
Amount held by Company	4 000 000			
			5 000 000 00	
				3 471 000 00
Current Liabilities.				
Including vouchers and pay rolls and amount advanced in anticipation of sale of Bonds on Algoma Branch			$7 036 820 69	7 036 820 69
Note.—Algoma Branch First Mortgage Bonds, £750 000 in Treasury, sold early in 1888, realizing $3 467 500.				

BALANCE DUE ON LAND SOLD.			INTEREST ON FUNDED DEBT AND RENTAL OF LEASED LINES.			
Deferred payments	.....	1 252 857 10	Coupons not presented, including amounts due January 1, 1887	$1 015 361 24		
Cash in treasury	.....	1 014 802 11	Accrued to date, not due	234 827 82	.....	1 250 189 06
NOTE.—14 934 237 acres of land unsold, valued at $2 per acre, $29 868 474.			CASH SUBSIDY PAID BY DOMINION GOVERNMENT		.....	25 000 000 00
			LAND GRANT.			
			3 272 749 acres sold, amounting to	$10 236 541 45		
			Less expenses, rebates and 10 per cent. premium on L. G. Bonds taken in payment	1 811 368 81	$8 425 172 64	
			6 793 014 acres taken by Government, to $1.50 per acre		10 189 521 00	18 614 693 64
			TOWN SITES.			
			Amounts received from the sale of Town Sites not covered by Land Grant Mortgage		$915 342 95	
			Less expenditure grading streets, buildings, etc., at Vancouver		304 855 30	610 487 56
			Bonuses received from Municipalities		.....	307 600 00
		$165 548 810 70				$165 548 810 70

(Signed) I. G. OGDEN,
Comptroller.

The illustrations with this paper are:

A general map of the line of the Canadian Pacific Railway. Plate I.

A map of that part of the line between Beaver Station and Craigellachie, showing location of snow sheds. Plate V.

A topographical map of the line in the vicinity of the summit of the Selkirk range. Plate VI.

A profile of that part of the main line between Calgary and Sicamous, showing all heavy grades between the Atlantic and Pacific, and also the location of the snow sheds. Plate VII.

Plan of a standard divisional yard. Plate VIII.

Plate showing the various types of snow sheds, glance fence and split fence—also consolidation engine, tender and snow plough. Plate IX.

Three photographs of snow sheds, showing also overflow of an avalanche at shed portal, and a deep snow cut at summit of Selkirks. Plates II, III, IV.

Cut showing method of blasting snow slide.

Cut showing excavation of snow slide filled with trees.

Cut showing method of treating "Gumbo" Cuts.

PLATE V
TRANS. AM. SOC. CIV. ENGRS.
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KEEPER ON CANADIAN
PACIFIC RAILWAY.

Canadian Pacific Railway

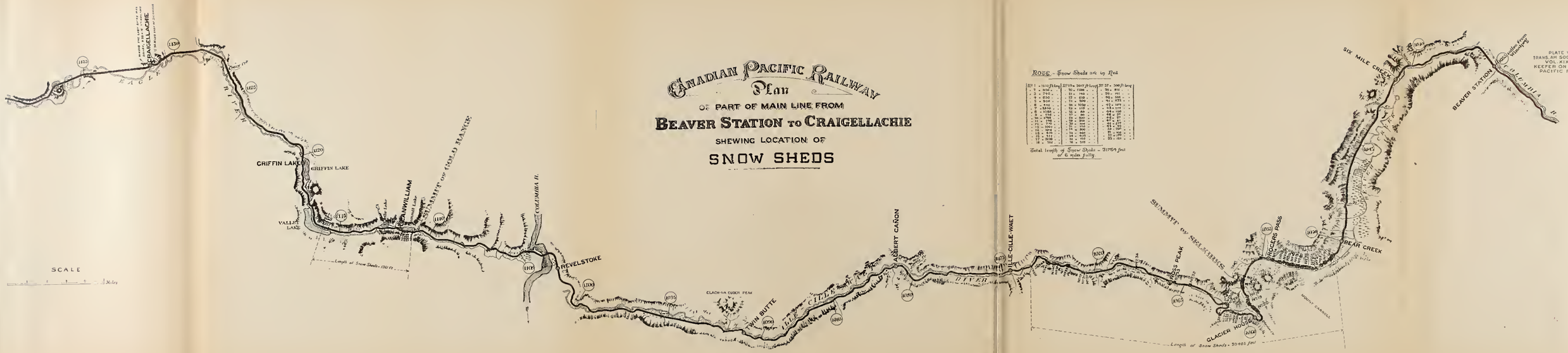
Plan

OF PART OF MAIN LINE FROM

Beaver Station to Craigellachie

SHEWING LOCATION OF

SNOW SHEDS



Roge - Snow Sheds are as Red

No 1 - 1300 ft long	No 27 - 300 ft long	No 37 - 300 ft long	
2 - 600 "	28 - 1000 "	38 - 810 "	
3 - 750 "	29 - 150 "	39 - 144 "	
4 - 650 "	30 - 600 "	40 - 144 "	
5 - 600 "	31 - 500 "	41 - 133 "	
6 - 550 "	32 - 1000 "	42 - 133 "	
7 - 1250 "	33 - 110 "	43 - 117 "	
8 - 1150 "	34 - 80 "	44 - 100 "	
9 - 1150 "	35 - 80 "	45 - 87 "	
10 - 1750 "	36 - 600 "	46 - 87 "	
11 - 170 "	37 - 350 "	47 - 87 "	
12 - 170 "	38 - 350 "	48 - 87 "	
13 - 1000 "	39 - 150 "	49 - 87 "	
14 - 1000 "	40 - 300 "	50 - 87 "	
15 - 1000 "	41 - 300 "	51 - 87 "	
16 - 1000 "	42 - 400 "	52 - 87 "	
17 - 1000 "	43 - 400 "	53 - 87 "	
18 - 1000 "	44 - 300 "	54 - 87 "	
19 - 1000 "	45 - 300 "	55 - 87 "	
20 - 1000 "	46 - 300 "	56 - 87 "	
21 - 1000 "	47 - 300 "	57 - 87 "	
22 - 1000 "	48 - 300 "	58 - 87 "	
23 - 1000 "	49 - 300 "	59 - 87 "	
24 - 1000 "	50 - 300 "	60 - 87 "	
25 - 1000 "	51 - 300 "	61 - 87 "	
26 - 1000 "	52 - 300 "	62 - 87 "	

Total length of Snow Sheds - 31759 feet
or 6 miles fully.

PLATE VI.
TRANS. AM. SOC. CIV. ENG'NS.
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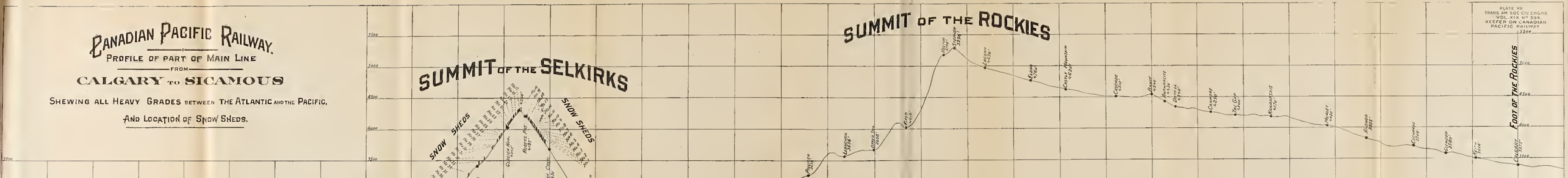
KEEFER ON CANADIAN
PACIFIC RAILWAY.
MAP
SHEWING THE
CANADIAN PACIFIC RY
IN THE VICINITY OF SUMMIT OF
SELKIRK RANGE.
SCALE 1½ IN = 1 MILE.
MOUNT SIR DONALD
ELEV. 10645 FT.
GLACIER HOTEL
ROGS PEAK
ELEV. 7616 FT.
ILLE-CILLE-WAET RIVER
SUMMIT
MOUNT CHEOPS
ELEV. 8670 FT.
MOUNT McDONALD
ELEV. 3440 FT.
ROGERS PASS STA.
BEAR CREEK
BEAVER RIVER.
MOUNT HERMIT
ELEV. 9665 FT.
EXPOSURE OFFICE DONALD.
J.E. GIVEN


CANADIAN PACIFIC RAILWAY.
PROFILE OF PART OF MAIN LINE
FROM
CALGARY TO SICAMOUS
SHEWING ALL HEAVY GRADES BETWEEN THE ATLANTIC AND THE PACIFIC,
AND LOCATION OF SNOW SHEDS.
SUMMIT OF THE ROCKIES
SUMMIT OF THE SELKIRKS
SUMMIT OF GOLD RANGE
SNOW SHEDS
SNOW SHEDS
SNOW SHEDS
FOOT OF THE ROCKIES
PLATE VII
TRANS AM SOC CIV ENGNS
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KEEFER ON CANADIAN
PACIFIC RAILWAY

PLATE VIII
TRANS. AM. SOC. CIV. ENGNS.
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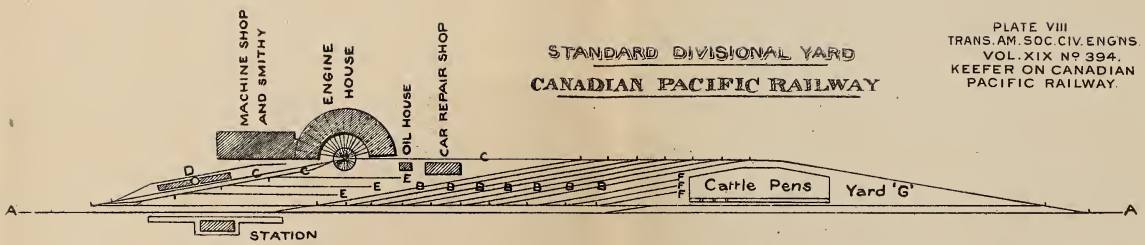
KEEFER ON CANADIAN
PACIFIC RAILWAY.

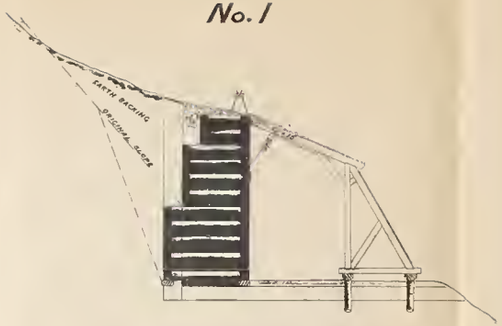
STANDARD DIVISIONAL YARD
CANADIAN PACIFIC RAILWAY



REFERENCES.

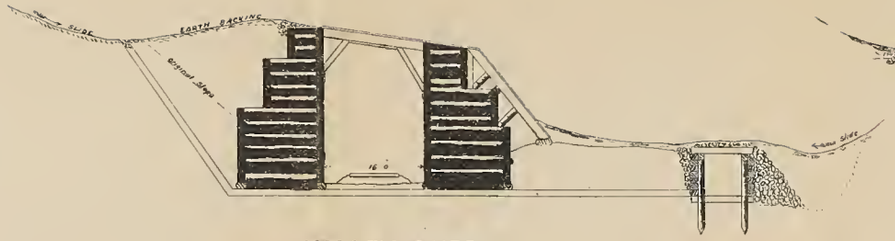
A. A. *Main Track.* — B. B. B. *Train Tracks.* — C. C. C. *Engine House Tracks.* — D. *Coal Track.* — E. E. E. *Car Repair Tracks.* — F. F. F. *Tracks for Pile-driving Cars, Derrick Cars, Snow Plows and other Emergency Equipment.* — G. *Yard for Piles, Bridge Timber and Emergency Materials.* —

No. 1



TYPICAL SHED.

No. 2

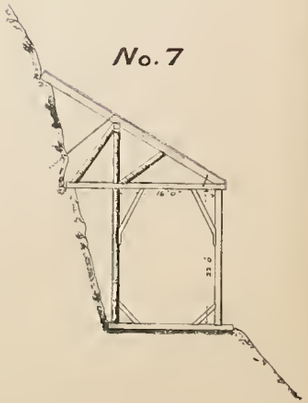


VALLEY SHED.

No. 3

TYPICAL SHED.

No. 7



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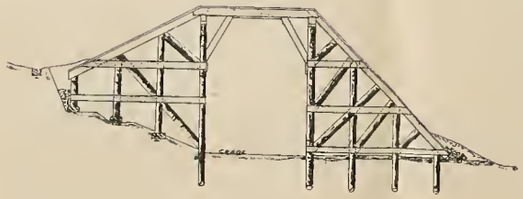
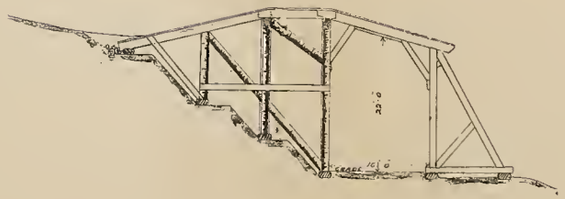
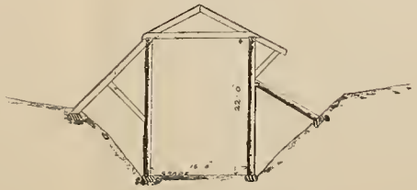


No. 9



No. 10

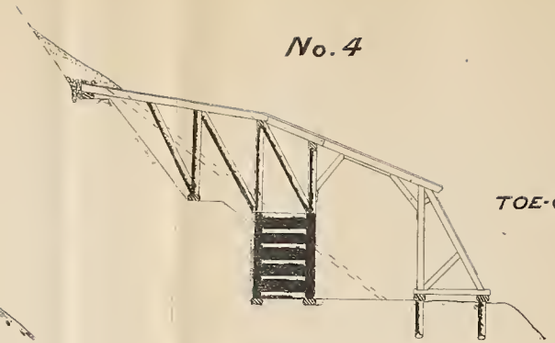


LEVEL FALL SHED.

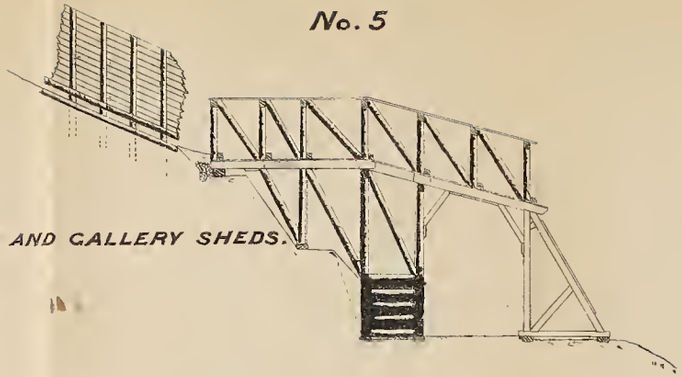
G A L L E R Y S H E D S

PLATE IX
TRANS. AM. SOC. CIV. ENGNS.
VOL. XIX Nº 394.
KEEFER ON CANADIAN
PACIFIC RAILWAY.

No. 4



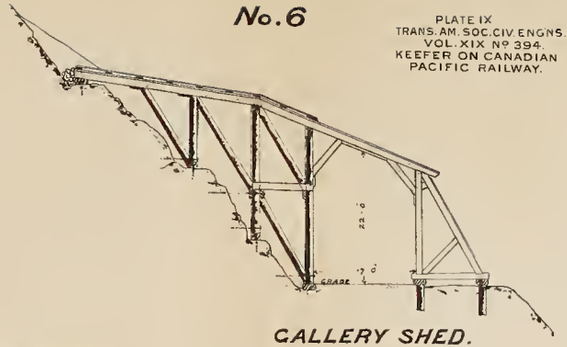
No. 5



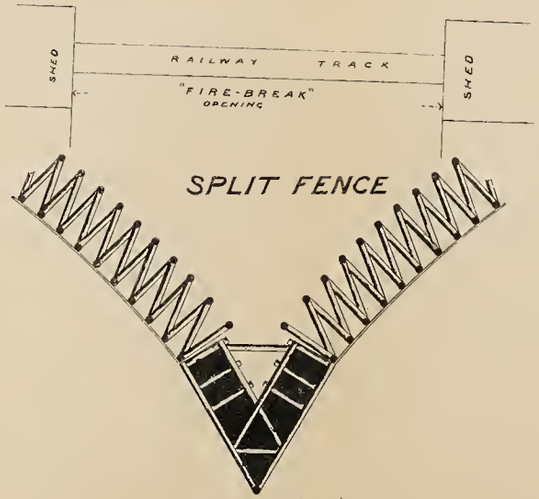
TOE-CRIB AND GALLERY SHEDS.

SCOOP SHED

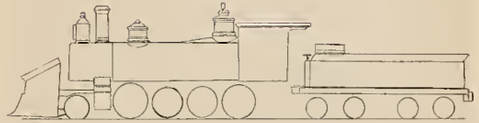
No. 6



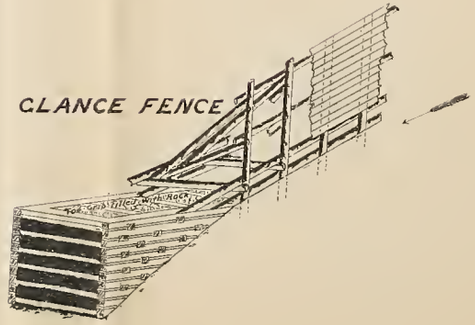
GALLERY SHED.



SPLIT FENCE



OUTLINE OF CONSOLIDATION ENGINE AND TENDER.



GLANCE FENCE

C. P. Ry.

SNOW SHEDS.

SCALE 20 Ft. = 1 INCH.